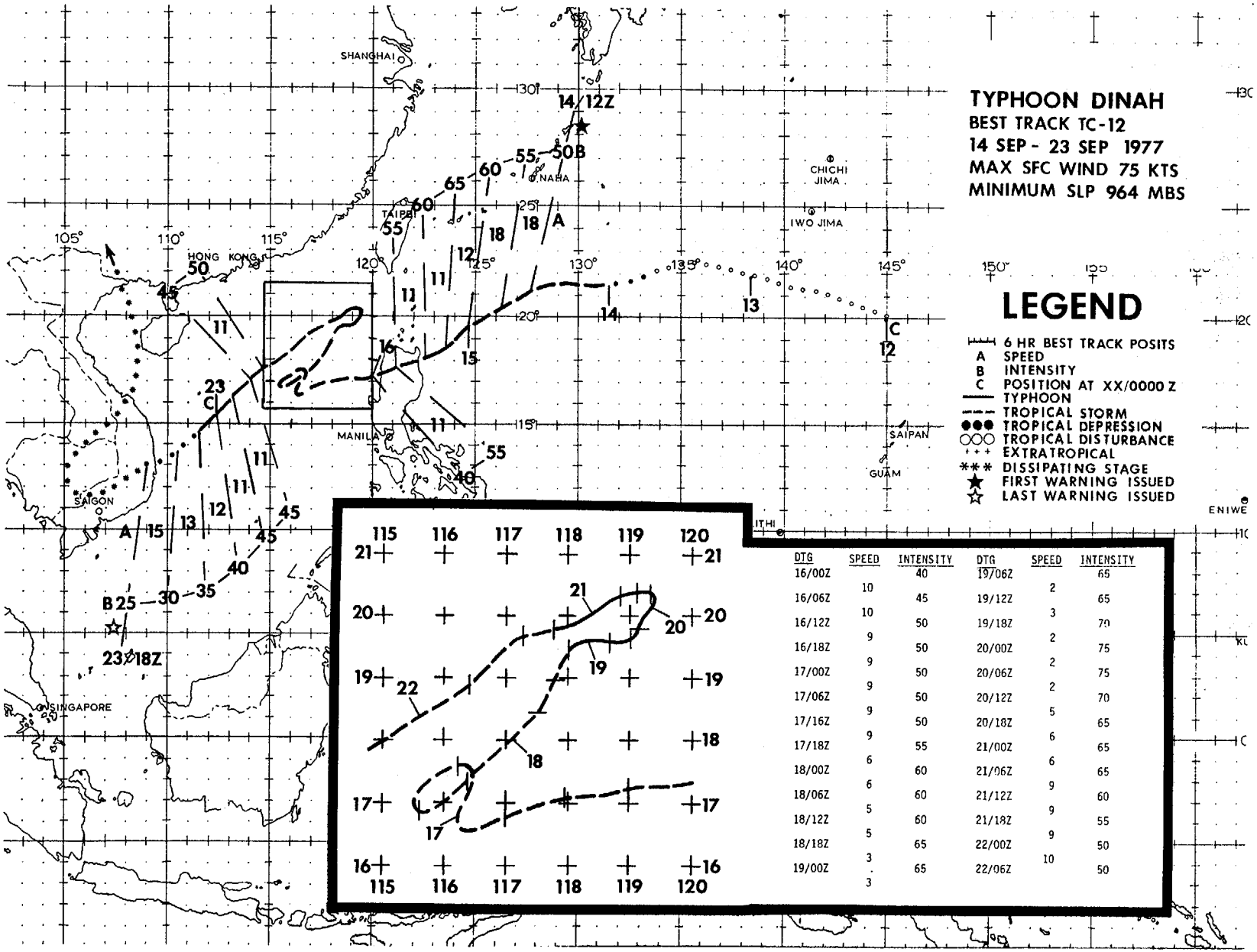

DTG	SPEED	INTENSITY	DTG	SPEED	INTENSITY
16/00Z		40	19/06Z		65
	10			2	
16/06Z		45	19/12Z		65
	10			3	
16/12Z		50	19/18Z		70
	9			2	
16/18Z		50	20/00Z		75
	9			2	
17/00Z		50	20/06Z		75
	9			2	
17/06Z		50	20/12Z		70
	9			5	
17/16Z		50	20/18Z		65
	9			6	
17/18Z		55	21/00Z		65
	6			6	
18/00Z		60	21/06Z		65
	6			9	
18/06Z		60	21/12Z		60
	5			9	
18/12Z		60	21/18Z		55
	5			9	
18/18Z		65	22/00Z		50
	3			10	
19/00Z		65	22/06Z		50
	3				

Dinah, the 5th typhoon of 1977, displayed the most unusual behavior. While over the South China Sea, the storm executed two hairpin turns and one loop before meandering over South East Asia during dissipation. Dinah's development, however, was a more normal sequence of events.

"Super" Typhoon Babe's extensive circulation system aided the monsoon trough to move north of its normal location. After Babe dissipated over eastern China, the monsoon trough extended from South East Asia to the Mariana Islands along 20 degrees north latitude. South of the trough, deep southwesterly flow produced localized gale force winds and extensive areas of thundershower activity. North of the trough, steady easterlies prevailed. Although the opposing currents produced considerable cyclonic shear and relative vorticity within the trough, the counter productive northeasterlies in the upper troposphere produced enough vertical shear to prevent significant tropical cyclone development. Meteorological satellite data during this 2nd week of September period showed several loosely organized areas of convection within the monsoon trough. On the 12th, synoptic data located a low level circulation center 400 nm (741 km) north of Guam. Maximum intensity near the center was estimated to be 20 kt (10 m/sec) while localized gale force winds continued within the southwest monsoon current to the southern and eastern periphery of the monsoon trough. (Islanders in the southwest flow could not believe there was not a tropical storm or typhoon nearby.)

The circulation center initially moved northwestward at an average speed of 16 kt (30 km/hr). Synoptic reports and satellite imagery revealed a tropical upper-tropospheric trough (TUTT) oriented east-west and just north of the position of the low to mid-level monsoon trough. By 1200Z on the 12th, a westward moving cyclone within the TUTT became positioned northeast of the surface disturbance. This orientation relieved much of the previously inhibiting vertical shear and provided an area of divergence aloft. This new flow pattern permitted the surface disturbance greater vertical growth and intensification. Satellite data soon identified a distinct vortex which separated from the areas of southwest monsoon cloudiness (Fig. 4-13). At 0100Z on the 14th, a formation alert was issued. The disturbance now moved westward as it entered the steering influence of an anticyclone over the East China Sea. Satellite pictures soon showed larger and better developed banding features. Since corresponding surface reports also indicated intensification, the first warning was issued for TD 12. Post analysis, however, found that the disturbance had achieved tropical depression intensity by 131800Z and tropical storm stage by 140000Z (Fig. 4-14). This was the period of maximum TUTT interaction. Because of the favorable conditions present during this time, another disturbance about 300 nm (556 km) north of Guam developed into Tropical Storm Emma.

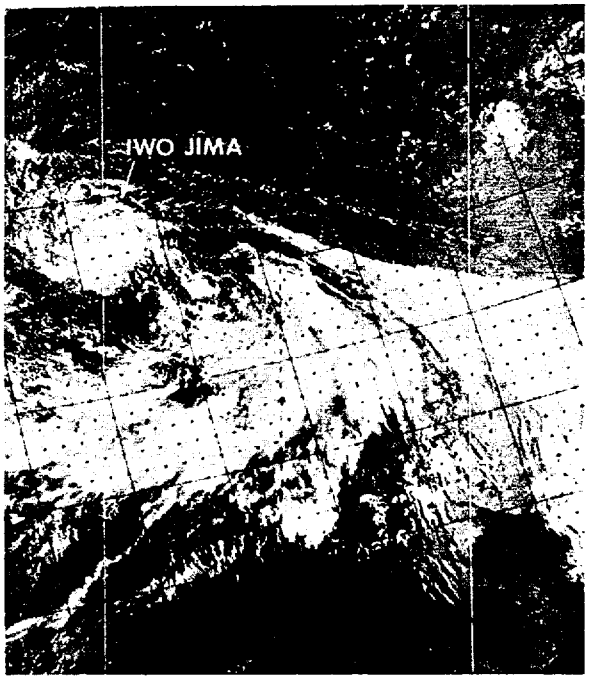

FIGURE 4-13. Tropical Depression 12 (Dinah) 225 nm (417 km) southwest of Iwo Jima while breaking away from its place of origin, the monsoon trough, 12 September 1977, 2310Z. (NOAA-5 imagery)

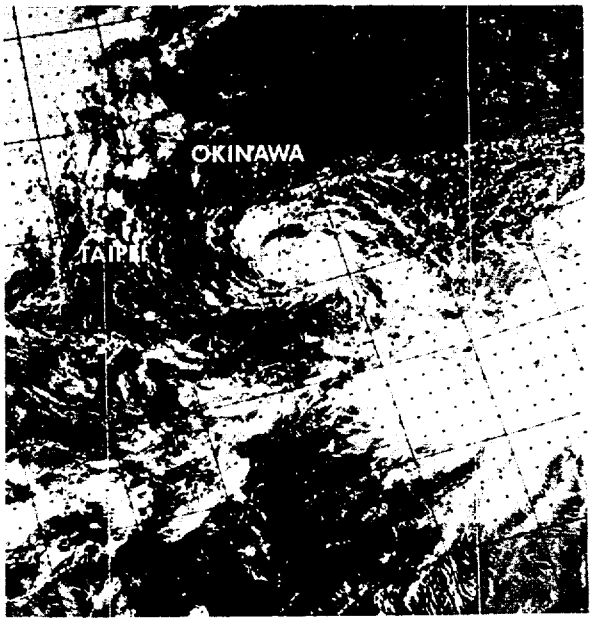

FIGURE 4-14. Dinah at tropical storm stage intensifying in an interesting split configuration, 14 September 1977, 0023Z. Dinah appears to be composed of two, comma-shaped convective systems rotating cyclonically with a narrow zone of relative subsidence between them. (NOAA-5 imagery)

As TD 12 grew and became Tropical Storm Dinah, the pressure gradient between the storm and the subtropical ridge increased. The associated easterly steering currents correspondingly increased and accelerated Dinah to a maximum speed of 19 kt (35 km/hr). An intensifying, mid-tropospheric high over eastern China was now the primary source of these easterlies. As this high pressure cell continued to build, Dinah was steered in a southwesterly direction towards the Republic of the Philippines. Forward speed decreased as the gradient slackened. Steady intensification continued as upper level outflow was well established in all quadrants. This trend persisted until Dinah reached minimum typhoon strength at 150600Z just 100 nm (185 km) off northern Luzon. With a maximum intensity of 55 kt (28 m/sec), the storm entered Luzon 35 nm (65 km) south of Escarpada Point at 151500Z. That evening Dinah passed near Tuguegarao, a station in northeastern Luzon which experienced 96 kt (49 m/sec) peak winds and a mean sea-level pressure of 977.0 mb.

Upon entering the South China Sea after 7 hours over land, Dinah weakened to 40 kt (21 m/sec), but quickly reintensified to 50 kt (26 m/sec) winds within 14 hours. Headed west-southwestward, Dinah entered an area of weaker steering currents. The dominating anticyclone over China was beginning to weaken and mid-latitude westerlies began extending southward. By the 17th, the continued weakening of steering currents caused the storm to slow to 9 kt (17 km/hr) movement.

For the next 4 days, Dinah exhibited unusual behavior. The weakening subtropical ridge over China broke down into a series of smaller high cells while the southwest monsoon deepened. Caught between these oscillating and opposing steering sources, Dinah abruptly turned northeast and then executed a loop during the 17th. As the southwest monsoon strengthened and became the dominant steering flow, the storm was directed northeastward toward Taiwan.

Intensification resumed as a result of the enhanced monsoon. The weakening subtropical ridge and increasing outflow aloft also contributed to Dinah's growth. By 181800Z, typhoon strength was again achieved. After being displaced north nearly 150 nm (218 km), movement slowed to 5 kt (9 km/hr) as Dinah's steering flow became less effective. By the 19th an advancing mid-latitude trough over China aided in steering Dinah eastward. Sustained winds of 65 kt (33 m/sec) persisted as satellite imagery at 191201Z revealed an eye. At 200000Z, Dinah reached a short-lived maximum intensity of 75 kt (39 m/sec) (Fig. 4-15). Ever since Dinah's origin, the southwest monsoon was the major feeding current. By 200600Z, this flow was being diverted into the beginnings of Tropical Storm Freda in the Philippine Sea and Dinah began to weaken.

As the mid-latitude trough advanced over China, it did not dig south as forecast and a large high pressure area built in behind it. In response, Dinah did not continue eastward in advance of the trough; it slowed to 2 kt (3.7 km/hr), turned westward, then southwestward being influenced by the intensifying high over China. Dinah was the first storm to be directly affected by an early autumn surge in the northeast monsoon.

The northeasterlies from the strong high over China controlled Dinah's movement for the next 2 days. Diminishing moist southwesterlies and increasing dry northeasterlies steadily weakened the storm. Dinah accelerated southwestward and reached south Vietnam as a weak tropical depression at 231700Z. JTWC's last warning was issued one hour later.

After landfall, Dinah, in its dissipating stage, persisted for 4 days. Tropical Storm Freda and the weakening of the northeast monsoon were the controlling agents in the last days of Dinah's unusual track. After crossing the South China Sea, Freda entered southern China drawing the southwest monsoon northward. Once again embedded in a southwest steering current, TD 12 (Dinah) journeyed northward through Cambodia, northeastward over the Gulf of Tonkin then northward into southern China and finally dissipated.

Dinah's sweep across northern Luzon caused loss of lives and property. Floods and landslides alone caused 15 deaths and 11 missing. Although Dinah remained a safe distance from mainland China while jogging unpredictably over the South China Sea, Hong Kong displayed the Stand By Signal No. 1 for a record 124 hours and 40 minutes.

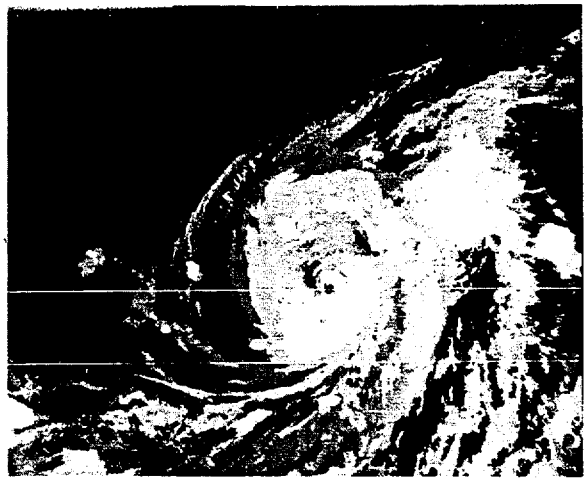

FIGURE 4-15. Infrared, threshold photograph of Typhoon Dinah at maximum intensity of 75 kt (39 m/sec), 19 September 1977, 2310Z. This special product consolidates the thermal range into four slices (gray shades) with white being coldest and black warmest.
Black: greater than 253°K; dark gray: 253° to 233°K; light gray: 233° to 213°K; white: less than 213°K.
(DMSP imagery from Det 5, 1WW, Clark AB, RP)